Gender and Race/Ethnic Representation in STEM Fields

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Table of Contents

ACKNOWLEDGEMENTS III

ABSTRACT IV

INTRODUCTION 1

GENDER INEQUALITY IN STEM 4

RACIAL INEQUALITY IN STEM 5

SIGNIFICANCE OF REPRESENTATION BY GENDER/RACE IN STEM 7

ACADEMIC PREPARATION 8

DISTIGUISHING BETWEEN GENDER AND RACE/ETHNICITY 8

SIGNIFICANT FACTORS FOR GENDER UNDERREPRESENTATION IN STEM 8

- Gender: Attitudes and Goals 10
- Role Models 14

SIGNIFICANT FACTORS FOR RACE/ETHNICITY UNDERREPRESENTATION IN STEM 16

- Tracking 16

RECENT DATA ANALYSIS 20

- CRDC Descriptive Analysis 20
  - Figure 1 22
  - Figure 2 24
  - Figure 3 26
  - Figure 4 27
  - Figure 5 29
- NCES Descriptive Analysis 30
  - Figure 6 33

EXISTING SOLUTIONS AND THEIR STRENGTHS AND WEAKNESSES 34

- STEM Inclusive High Schools 34
- HBCU’s 36
- Informative Sessions- ADVANCE 38

CONCLUSION 39

REFERENCES 43

AUTHOR BIOGRAPHY 48

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Abstract

The STEM fields have become increasingly popular due to the relevance, competitive, and rigorous nature of the fields as well as the availability of jobs in the workforce. The most common and traditional path to enter the STEM workforce is to major in one of the many STEM disciplines. Despite overall increased interest in STEM, women and people of color are still significantly underrepresented. It is essential to increase diversity and representation in STEM careers because diversity is proven to increase creativity, productivity and uniqueness of thought. Many longitudinal studies have investigated specific factors that influence disproportionate representation in STEM. Although there is not one clear cause of inequality, research finds that student and teacher attitudes, the availability of STEM role models, and academic preparation have had significant impact on this in the past. After analyzing the current literature regarding factors contributing to underrepresentation in STEM, this thesis analyzes current longitudinal data from US public high schools. The level of high school mathematics offered and taken by students has a significant impact on their preparedness to enter STEM fields, and this has implications for increasing racial diversity. The underrepresentation of females and racial/ethnic minorities in STEM is apparent to experts in the field, and many current solutions have been instituted in order to attempt to increase diversity in the field. However, no existing solution is perfect due to the complexity of the issue.

Keywords: STEM education, race, gender, inequality

(Word count: 233)

Introduction

The STEM fields, defined as the Science, Technology, Engineering, and Mathematics fields, are highly competitive due to the relevance, significance, high paying salaries and prestigious nature of the field. STEM majors require a myriad of rigorous coursework in order to obtain an undergraduate degree. Historically speaking, the STEM fields are predominantly occupied by White men (Blume-Kohout, 2014). This has been the case since the introduction of these disciplines in the United States (Blume-Kohout, 2014).

One of the potential reasons for underrepresentation in STEM, particularly racial/ethnic underrepresentation, stems from access to coursework in high school. Many of these fields of study follow a strict linear path throughout a student's education, from the introductory courses to more advanced courses in the field. Mathematics, in particular, is a subject that builds upon previous courses starting from the elementary mathematics courses in early childhood education. One of the gatekeepers to STEM coursework is academic tracking. Tracking, or leveled coursework, has many beneficial intentions, such as providing students with a classroom environment that is the correct level of difficulty and pace, but there are negative repercussions. If students are not placed in a high level of math from an early age, due to a myriad of reasons that will be discussed in this thesis, it can be extremely difficult to catch up or advance to a higher-level math course in the future due to the cumulative nature of the subject (Tyson, 2011).

A significant majority of people who are entering the STEM workforce have either had previous experience in a science, math, engineering, or technology occupation, or have studied and majored in one of the fields. Due to the complex and specialized nature of the STEM fields, it is highly unlikely that people are entering the workforce looking for STEM jobs who did not study some sort of STEM subject in college or graduate school. Therefore, this thesis argues that the underrepresentation in these fields is emerging from an earlier stage than the job recruiting process. This underrepresentation of racial/ethnic minorities and females is stemming from an inequality in the United States' education system. In particular, for women, many of the reasons for female underrepresentation in STEM careers are due to a lack of female role models and different goals and attitudes that females hold, as a result of gender socialization. For racial/ethnic minorities, the differences in high school course offerings for mathematics across the country is significant. While some high schools offer multiple levels of Advanced Placement (AP) calculus, some high schools do not offer pre-calculus, let alone calculus. If students are not entering college with a sufficient foundation in mathematics, they are unlikely to pursue introductory mathematics courses in their first semesters of college (Sadler & Sonnert, 2018). This will, in turn, make it difficult for these students to major in the field, as two to three semesters of calculus is a prerequisite for almost every STEM major (Hagman, Johnson, & Fosdick, 2017). As for those high schools that do offer high level mathematics, the same situation arises for students at schools that offer advanced mathematics, but who do not take the highest level available. If these students enroll in introductory calculus courses in their first semester of college, many of their classmates could be students who have already taken the equivalent of a semester or two of college level calculus. This can be extremely intimidating and discouraging for students who have not been previously exposed to the subject (Harris 2011).

One of the reasons that there are disparities in access to coursework beween schools is a result of school segregation. Whether that be urban, suburban, or rural areas, much of a child's education has to do with the school district and system that they are a part of. It is clear that many districts are underfunded and do not have the same amount or quality of resources as other school systems. This inequality can be perpetuated in many areas, not just the STEM fields. The demographics of a certain city or area can be extremely complex. People choose where to live based on multiple factors, including but not limited to, taxes, rent, family, jobs, school district and affordability. However, it is out of a child's control which school system they are born into, and therefore their potential opportunities should not be limited due to such circumstances (Lewis & Diamond 2017).

Scholars in the field have been studying ways to support more Black and Brown students in STEM, as well as females, and have tested out multiple ways to increase representation. While many of the existing potential solutions have aspects that increase minority representation in the field, each solution contains flaws and potential areas of improvement. If scholars and leaders in the field continue to research solutions and strategies to increase minority representation in STEM, there could be several methods that could help even out the playing field for everyone. It is also possible that different aspects of various pre-existing solutions can be melded together to create an even more efficient and effective solution.

This work builds upon previous longitudinal studies using recent national data to examine the highest level of mathematics taken and representation in these courses by race/ethnicity and gender. This thesis concludes that yes women and people of color are underrepresented in the STEM workforce but the issues for females and racial/ethnic minorities are different. Two data sets were analyzed using descriptive statistics and chi-squared and statistical significance tests were conducted.

Gender Inequality in STEM

STEM has been a traditionally male dominated field, particularly White male. More specifically, as of 2013, 57% of women earned bachelor's degrees, while only 19% of women earned degrees in computer science (Charles & Thébaud, 2018). Similarly, 18% of women earned degrees in engineering, which is statistically significantly lower than those statistics for men (Kyte & Riegle-Crumb, 2017). Likewise, the number of females who have ambitions to enter the STEM workforce is lower than that of males who have ambitions to have a career in STEM (Riegle-Crumb, Moore, & Ramos-Wada, 2011).

Due to the scope of this thesis and the diversity of STEM, this thesis will focus specifically on mathematics and its role in shaping the opportunities in STEM for students while they are studying to enter the workforce.

There are disparities by gender in professions within the STEM fields. Due to the variety and diversity of STEM, some majors, areas of study, and professions within STEM are represented dramatically different by gender. For example, the percentage of PhD's earned by females in 2012 was only about 15% for Aerospace and Mechanical Engineering (the most underrepresented in the field) compared to 64.3% for Medical Sciences, also known as doctoral students (the most represented in the field) (Blume-Kohout, 2014). The percentage of PhD's earned by females was 28.2% for the category defined by Blume-Kohout as Math & Statistics (Blume-Kohout, 2014).

For undergraduates, the case for women is complicated. Women make up about half of the undergraduate math degrees nationwide, so this does not appear to be the problem. At the undergraduate level, the underrepresentation is specifically in computer science and engineering. (Riegle-Crumb, 2017). When people who belong to a specific group that is not represented well in the field see their community is underrepresented, they have less ambition and drive to pursue such careers, as they do not feel as welcome or a part of the community (Stearns et al., 2016). It is evident that females are not the only underrepresented group in STEM. People of color are also significantly underrepresented. Therefore, it is important to acknowledge the underrepresentation and inequality for both females and people of color in STEM, but also important to focus on the intersectionality of gender and race as it is too general to summarize the female experience or the Black experience as race and gender play very large and different roles in the individual experience.

Racial Inequality in STEM

STEM has been a traditionally Caucasian dominated field, due to the historically White dominated workforce of the United States. Black and Latinx people are extremely underrepresented in the STEM workforce, specifically in the physical science and engineering fields (Riegle-Crumb & King 2010). “Blacks make up 11% of the U.S. workforce overall but represent 9% of STEM workers, while Hispanics comprise 16% of the U.S. workforce but only 7% of all STEM workers. And among employed adults with a bachelor’s degree or higher, blacks are just 7% and Hispanics are 6% of the STEM workforce” (Funk & Parker, 2019).

Riegle-Crumb and King’s study showed that Black and Hispanic youth are not underrepresented in STEM fields among college students. The fact is that they are less likely to go to college than Whites. But among college students, the percent of minorities who go into STEM is the same as the percentage of Whites. (Riegle-Crumb & King 2010).

A cycle of racial inequality starts far before the college process. Opportunities for students who attend public school in the United States can vary significantly based on the school district. There is a myriad of factors that influence this discrepancy, including taxes, funding, and teacher recruitment. Because the path to STEM careers is a cumulative process, the varying opportunities and coursework from a young age can impact a student's chances at succeeding in and/or enjoying STEM.

The demographics of rural and suburban areas of the United States have manifested in a way that sharply divides by race and socioeconomic class. Generally, there are higher concentrations of Black and Latinx communities in certain areas of the country, historically big cities, which can be traced back to policies created during pre-slavery and civil rights eras. However, research has found that more recently, Black and Latinx communities are migrating to suburbs. (Schaeffer, 2019). Although advancements have been made as time progresses, these divisions are deeply ingrained in American culture and society and will take significant efforts to reverse entirely. Current local and federal government priorities are designed so that a higher proportion of tax money will help areas where students have privilege than those neighborhoods and communities in need. In low income areas, there are other priorities that the government and lawmakers pay attention to, such as crime and infrastructure. When lower proportions of tax money are going towards education, quality of faculty and resources suffers. This can have a significant impact on a child's education, and as experts in the field have discovered, it can take just one negative experience for a child to lose interest in a particular field or area of study. Lewis & Diamond, 2017). This being said, it is not just high school and college preparation that can lead to racial underrepresentation in STEM, but the teachers and classroom resources from an early childhood classroom can be just as significant. Racial inequality in the U.S. is a complex issue, clearly influenced by many factors which all play a role in underrepresentation. In this instance, the underrepresentation discussed is in STEM careers.

Significance of Representation by Gender/Race in STEM

Diversity has been proven to increase creativity, productivity and uniqueness in thought (Powers, 2018). In recent years, many large firms, corporations, institutions and small businesses have strived to increase diversity in their organizations due to its many benefits. In a diverse field like STEM, where researchers and employees are searching for cures to disease, inventing technological solutions to complex problems, and creating algorithms to change the way humans communicate and interact online, diversity of thought is imperative. Diversity initiatives, like STEM inclusive high schools and Historically Black Colleges and Universities (HBCUs), allow companies to harness talent and foster the potential of communities of people who were traditionally neglected or passed over.

When students feel represented and identify with successful leaders in STEM, they possess the self-confidence to continue to pursue those subjects and skills as they grow up (Stearns et al., 2016). Conversely, when children or young adults grow up without those role models, those fields become heavily dominated by a single majority.

The significant problem with underrepresentation is that persistent inequality in STEM promotes a cycle of overrepresentation of the majority group in the field which in this case is White males. This is such a problem because regardless of race, ethnicity, or gender, individuals should be able to pursue careers that they are interested in and passionate about. Therefore, it is imperative to break this cycle and create opportunity and equality for those who want to enter the STEM fields regardless of their race and/or gender.

Academic Preparation

Many studies have been conducted that investigate various factors which influence racial/ethnic and gender imbalances in college majors. Scholars and experts in the field, Riegle-Crumb and King (2010), conducted a study using national longitudinal data published in 2002. This study concluded that although gender inequality still exists in the STEM field and STEM majors in college, when looking at gender (not accounting for race) it is not accurate to conclude that females are underrepresented in high school upper level math and science coursework. This equitable representation of women in higher level STEM high school coursework can be tracked back to the 1990's, as it seems this was when the representation was balanced. Yet this study did deduce that racial and ethnic minority students, more specifically Black and Latinx students, are less prepared academically than the dominant group, White males. Riegle-Crumb and King's work concluded that White males are not the most probable in wanting to pursue a degree in math or science, even though they are the largest represented demographic in math and science careers. This finding can cause interpreters of this data to infer that there are significant factors interfering with other groups' chances and paths to work in STEM (Riegle-Crumb & King, 2010).

Distiguishing Between Gender and Race/Ethnicity

The issue with underrepresentation in STEM is complicated considering there are two separate groups discussed; racial/ethnic minorities and females. Of course, the intersectionality of the two is significant and this thesis will touch upon that, however, it is important to note that the two groups have been proven to be underrepresented for differing reasons.

In STEM careers, Latinx and Black students are underrepresented relative to their proportion of the U.S population. However, unlike females, racial/ethnic minority students do in fact yearn to enter careers in STEM when they achieve their undergraduate degrees. Whether or not minority students are applying and enrolling in undergraduate colleges at representative rates is a separate discussion from the STEM interest, as this can also cause the proportion of minority students earning STEM degrees to be unrepresentative. In fact, accounting for the varying levels of academic preparation across the country discussed in this thesis, which does impact college enrollment, racial/ethnic minority students are as likely or more likely to enter STEM majors (Riegle-Crumb & King, 2010). This thesis argues that academic preparation is the largest factor for minority underrepresentation, which can also impact high school graduation rates as well as college interest and enrollment (Riegle-Crumb, King, Grodsky, & Muller, 2012). Yet it is important to note that Black and Latinx students do show interest in pursuing careers in STEM and are declaring STEM majors at the same rates as White students. This is critical, considering the inferior academic preparation discussed. Although it is simple to say that the level of academic preparation for racial/ethnic minority students should be increased to match that of the majority groups, it is difficult to execute, given the number of factors that contribute to academic preparation. But as this thesis is limited in terms of scope and resources, I will argue that attempting to even out the broad factor known as "academic preparation" will increase racial/ethnic minority representation in the STEM fields due to their relative equal or increased interest in the fields (Riegle-Crumb et al., 2012).

Conversely, for females, underrepresentation in STEM is not due to a lack of academic preparation which will be proved in this thesis. In the data sets analyzed, women are not significantly underrepresented in upper level mathematics courses or any math course for that matter. Many of the contributing factors that lead to female underrepresentation are linked to gender socialization. This is the idea that females and males are perceived to intend to pursue different careers, be interested in different hobbies, and more generally behave differently. This is what leads to jobs being considered as male stereotypical jobs and female stereotypical jobs that will be touched upon later in this thesis. This socialization in America creates a cycle of underrepresentation of females in STEM as young female students are less likely to see many role models of their gender represented as leaders and innovators in the field.

This thesis will first discuss gender factors, and circle back to race factors given the different influencers on educational experiences for minorities and women. In conclusion, when discussing the underrepresented populations in STEM, there are two differing populations, females and racial/ethnic minorities. For women, as Riegle-Crumb and King concluded, the underrepresentation arises from the socialization of gender and its implications. For example, a lack of role models, females' goals in a career, and attitudes surrounding the STEM careers. (Riegle-Crumb et al., 2012). For Latinx and Black students, the underrepresentation arises from deficient academic preparation, and more generally racism, which leads to socioeconomic disparities, and unequal opportunities in education (Riegle-Crumb, King, Grodsky, & Muller, 2012).

Significant Factors for Gender Underrepresentation in STEM

Gender: Attitudes and Goals

Riegle-Crumb and Kyte conducted a longitudinal study in 2017 examining women's attitudes and intent to pursue STEM careers and concluded that females are less likely to intend to pursue a career in STEM due to their attitudes and ultimate goals in a profession. The researchers used longitudinal data published in 2012 and explored how females perceive the social relevance of different STEM courses and if this perception is a significant factor influencing females' lower intentions to pursue STEM. As of 2013, 57% of women earned bachelor's degrees, but only 19% of women earned degrees in computer science and 18% earned degrees in engineering, statistically significantly lower than those statistics for men. (Riegle-Crumb, 2017). This Riegle-Crumb and Kyte study followed longitudinal data from a very diverse school area in the Southwest of America. Eighty percent of the students in the community are eligible for free and reduced lunch, 62% are Hispanic, 25% are Black, and 8% are White (Riegle-Crumb & Kyte, 2017).

In 9th grade, the students who participated in the study were asked how likely it is that they would major in a given field. The choices were "biological science, physical science, computer science and technology, and engineering". Only 47% of female students answered that they expect to major in the STEM field compared to 69% of boys. Similar to research done on this topic in the past, the percentage of young women who aim to study biological science and physical science is not significantly lower than the male percentage, but for computer science and engineering, the female expectations to major are significantly lower. In 8th grade, the same students were asked questions that were targeted to test their perception of the social relevance of science. For example, "disagree or agree, science is useful for solving everyday problems". The results showed that that overall, girls are less likely to intend to major in STEM, regardless of the fact that the high-level math and science courses in high school have equal representation for males and females. Similarly, students who believe science to be relevant in everyday life are more likely to major in STEM. Social relevance appears to predict female's intent and expectation to major in three of the four fields discussed in the survey. The only STEM field where social relevance did not increase the likelihood of a female majoring, was computer science (Riegle-Crumb & Kyte, 2017). This can be interpreted to mean that the perceived social relevance of a field is a significant factor for females considering the pursuit of a STEM career. This is significant in order to change the narrative surrounding certain fields that are not viewed as socially relevant to spark the interest in more women. Although academic preparation may not be the significant factor for female underrepresentation in STEM, social relevance is.

Amanda Diekman, Elizabeth Brown, Amanda Johnston, and Emily Clark (2010) researchers out of Miami University conducted a related study, looking at gender and goals and roles specifically in STEM. These experts have noticed that women are entering other stereotypical male professions (non-STEM) at higher rates than they are entering STEM fields. In other words, it appears that women are becoming more represented in other non-STEM male dominated fields than STEM fields (Diekman et al., 2010). Their study aimed to look at how STEM differs from other traditionally male dominated fields such as dentistry, medicine, law, and business (Diekman, 2009). The original hypothesis surrounded communal goals, which can be defined as “working with or helping other people” (Diekman, 2010). Diekman and colleagues predicted that other non-STEM male stereotypic (MST) jobs have more communal goals than STEM jobs are perceived to have. The researchers also note that “women tend to endorse communal goals more than men” (Diekman, 2010) and that females historically have practiced in more caretaking positions and female stereotypical jobs (FST) such as teachers, HR, Social work, and nurses, which can be correlated to communion goals (Diekman, 2010).

It is evident from Diekman’s research that the social role a profession holds can be a significant factor for pursuing a career. Diekman’s study was conducted with 333 psychology students asking students to rank different careers (MST, FST, and STEM) based on how they believed the career "fulfilled agentic goals and communal goals" (Diekman, 2010). After ranking how the goals related to different careers, the students rated how interested they are in the given FTS, MST, and STEM careers. After those two rankings, the students are asked how important different goals are personally from 1 (not important) to 7 (very important) (Diekman, 2010). Other factors were considered such as grades in STEM courses and self-efficacy models.

Firstly, aligned with the researchers' hypotheses, results showed that the non-STEM MST careers differed from STEM careers in terms of being aligned with communion goals. This can be interpreted to mean that students see communion goals in other MST jobs more than they do in STEM jobs (Diekman, 2010). Second, Diekman and colleagues predicted that the communal-goal endorsement would have a negative correlation with students' interests in STEM careers. "As predicted for STEM careers, communal-goal endorsement significantly inhibited interest, and agentic-goal endorsement facilitated interest" (Diekman, 2010). The study also showed that that women were more probable to support communal goals and communal goals in turn anticipate STEM interest, or a lack thereof.

In conclusion, Diekman argues that STEM careers are recognized to constrain communal goals, and therefore individuals who identify with strong communal goals are less likely and interested in pursuing a STEM career (Diekman, 2010). This can explain why even individuals, specifically women, who are gifted and successful in STEM courses, do not chose to pursue a career in STEM. Due to the fact that women are more likely to align with these communal goals, and that communal goals are not positively associated with STEM careers, these two factors could account for the stagnant underrepresentation in STEM compared to other MST careers. These Miami University researchers propose interventions on how STEM careers can be collaborative and helpful to the community. Once the narrative around STEM shifts to align with more communal goals, it is likely that more females will be interested in pursuing STEM careers (Diekman, 2010).

Role Models

A significant factor that influences the underrepresentation of women in STEM are role models or a lack of role models in this case. A paper written by Stearns and colleagues (2016) discusses how the proportion of female math and science teachers in high school impacts students', particularly females', decisions to major in STEM and graduate with a major in the STEM field. The authors began to look into this topic because while White women account for slightly under half of the workers in the US workforce, they only account for 25% of the STEM jobs (Stearns et al., 2016). This particular study was designed to determine if the race and gender composition of STEM faculty in high schools affect the majors that students chose (Stearns, 2016). As this thesis has discussed, women are not the only underrepresented group in this field. Research and studies previously conducted that have concluded that Black students are more likely to major in the STEM field if they have a Black instructor in high school for a particular STEM course.

In Stearns' study, the academic performance of North Carolina public schools was considered. The sample was from 540 middle schools and 350 high schools (Stearns, 2016), and followed the students into any of the sixteen UNC schools across the state. Seventeen percent of students entering a UNC school declared a STEM major and 19% of graduates ended up graduating with a STEM degree. Forty three percent of the sample were males, while 57% of the students graduating with a STEM degree were men. The study looked at the students who were declaring STEM majors and graduating with those majors and the proportion of female STEM teachers at their high schools. The results showed that White females who attend high schools with a larger proportion of White female math and science teachers, are more likely to major in STEM fields. This is not necessarily the case for African American women. African American females' STEM outcomes are not associated with the increasing number of White female math and science teahcers, but rather female teachers in STEM in general (Stearns, 2016). It was also found that the decision to enter a STEM field is not only impacted by college experiences. High school is a critical time to make decisions about the future and careers that a student can envision him or herself taking on (Stearns, 2016).

Stearns argues that teachers can serve as either active or passive representatives in the classroom, and having female teachers, active or passive, aids female representation in the STEM fields (Stearns, 2016). Passive female representatives are those who serve as an example and role model. Young girls can see people like them exist in the field and that their goals and paths are obtainable. Because STEM is a White male dominated field, females and people of color can be lacking role models and/or representatives in the field. Simply having an abundance of female representatives can show other females that they can overcome barriers and that success in the field is possible. Teachers can also serve as active representatives, encouraging females and people of color to participate more consciously. This happens more frequently with female teachers than males. The presence of female faculty has been proven to increase STEM involvement for all students regardless of gender or race. (Stearns, 2016). Considering this research proved that female role models do play a significant role on females' decisions to pursue STEM careers, it is imperative to advocate for more female representation in STEM to serve as role models to encourage more minority representation.

Significant Factors for Race/Ethnicity Underrepresentation in STEM

Tracking

Tracking in education refers to grouping students with similar academic abilities in the classroom. Depending on the school district and type of school, public or private, tracking can begin as early as kindergarten, but generally surfaces in middle school and high school (Tyson, 2011). Tracking has become a habitual part of American schooling with many positive intentions. While the intentions of tracking are positive, the consequences and research show otherwise (Oakes, 2005).

Jeannie Oakes, an expert on student tracking, conducted many studies on tracking that conclude that tracking yields few benefits for students designated as “slower” learners (Oakes, 2005). Although tracking is believed by many to have positive influences on students, the system is flawed and argued to be only in place due to tradition in the culture of the school system and out of old habits that have been in place for decades (Oakes, 2005). An important piece of information to note is that students are labeled into different categories, often times at a young age, very publicly. It is clear that there is a certain hierarchical aspect to these labels in terms of peers, teachers, and family members (Oakes, 2005). Similarly, teachers are aware of how significant a students’ track placement is on their education which is why multiple inputs determine the specific track (such as test scores, teacher and counselor recommendations, and student and parent choices) and why incorrect placement can become an issue that involves parental involvement and discussion (Oakes, 2005).

Oakes argues that the positive intentions of tracking are due to a variety of assumptions, most of which are not proven to be true or have proven to have opposing consequences.

Grouping students who learn at similar paces together in a classroom is assumed to promote better learning environments for all types of students. The intent is that high achieving students will not be held back by the slower learners and the slower learners will not feel overwhelmed and behind from those who pick up on material quicker. Another assumption held is that when students feel more comfortable in their learning environment, they are more likely to ask for assistance and speak up when confused or in need of extra support. An additional presumption is it is easier for teachers to teach and handle a group with students of similar learning abilities (Oakes, 2005).

Unfortunately, the intentions of tracking have the opposite effects in the classroom. Oakes researches tracking, its assumptions, and consequences which have proved that grouping by learning capability does not benefit any group of students' learning: the advanced students or the below average students. Not only does no group benefit, but the average and slower learners are actually harmed by this homogenous grouping (Oakes, 2005). The assumption that advanced students are held back or not able to reach their ultimate potential in a heterogenous classroom (in terms of learning ability and pace) is also proved to be a false assumption (Oakes, 2005). When addressing the assumption that students will feel more confident in classes surrounded by students who learn at similar paces, Oakes also disproves this. The students who are categorized as slower learners are harmed by this grouping and although faster learners were not proven to be harmed, Oakes did not find any benefits.

Circling back to the fact that the labels of classes are very public and there are negative and positive connotations to the given levels, students in lower levels show deflated levels of self-esteem, while students in advanced and above average levels show inflated levels of self-esteem (Oakes, 2005). Oakes also notes that other factors such as race, gender, socio-economic statues, etc. have been controlled for in these studies. While controlling for these factors, students in lower level classes are more likely to be involved with negative behavior outside of the classroom. These include lower participation in extracurriculars, higher levels of misbehavior, alienation, high dropout rates, etc (Oakes, 2005).

It is important to note that in a subject like mathematics, once a student is placed in a certain level, it can be difficult to move up to more advanced levels in the future. Once placed in a particular level, the rigor and speed of learning differ. Therefore, moving up levels could require additional time and resources in order to feel comfortable in a more advanced course (Oakes, 2005).

Many factors contribute to the level in which students are placed for particular subjects. The teacher/counselor's recommendation, testing, and parental and student's decision, can influence the level of class in which a student is placed (Oakes, 2005). However, teacher biases can influence the level in which they place their students. This can have a negative impact on students of color and females if the teacher carries implicit or unconscious biases. Counselors could also have up to 500 students to place and it could be unlikely that teachers or counselors in large public schools have a true personal relationship with their students. This can result in counselors or teachers using other factors to determine a student's placement level such as "dress, speech patterns, ways of interacting with adults, and other behaviors" which can be "influenced by race and class" (Oaks, 2005).

Similarly, high stakes testing that determines a course level for a student can be determinantal to the student's future. Because tests can contain cultural and language biased questions, "White middle-class children are most likely to do well on them" (Oakes, 2005) due to "the compatibility of their language and experiences with the language and content of the test questions" (Oakes, 2005). This results in lower-class and minority students' lack of success in placement tests. Additionally, some students could not perform well under high stakes testing conditions and this could result in incorrect placement.

When considering a students' decision to choose a certain level of a course, students of color or females might be in the minority in a higher-level course and not feel comfortable or represented. If this is the case, students will not perform to their highest ability, and this could hurt their grades and/or learning capacity in the long term (Tyson, 2011). Some students opt. out of higher-level courses even if they are recommended or place into them, due to a lack of race/ethnicity or gender representation. This can contribute to a cycle of underrepresentation for minority groups in STEM. Researchers and experts are still unsure of how to break this feeling of discomfort and misplacement. It is important to understand that a student's decision is not "made free of influence" (Oakes, 2005).

Another issue with tracking is that not only are students in lower levels covering less material, the material is proven to be less engaging and of a significantly lower difficulty level (Tyson, 2011). The textbooks and workbook materials are not of the same caliber as more advanced coursework, and therefore, tracking is harming these students in the less advanced classes while giving an advantage to students in higher levels. As a result, students attending the same schools, can be receiving an extremely unequal education in certain subjects. It is important to consider that Black and Latinx students are statistically overrepresented in the lower level courses while White students are extremely underrepresented and vice versa (Tyson, 2011). Oakes argues that although tracking has become habitual in the United States due to the fact that there are positive intentions, "it is not worth the educational and social price we pay for it" (Oakes, 2005). Although it might seem as though the education system could not possibly function without academic tracking, that is simply because as a society, this idea is ingrained in the perception of U.S. schooling, but it is truly not a necessary practice, especially if it is harming student growth. It is only currently existing due to habit and tradition (Oakes, 2005).

Recent Data Analysis

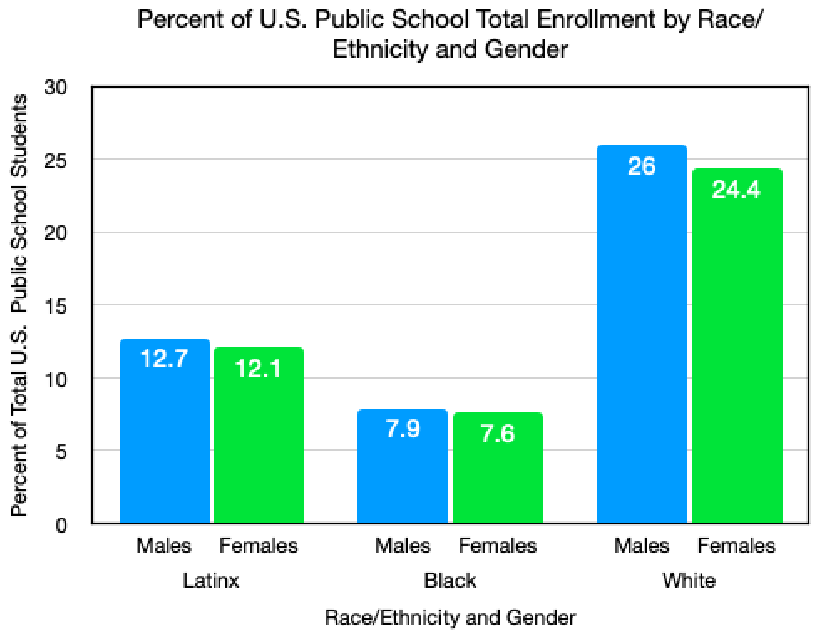
While many in depth analyses have been performed using the U.S. longitudinal data from the late 90's and 2002-03 data, recent national data is also available. Due to the scope of this thesis and the restriction of data, this thesis will draw from two sources, the Civil Rights Data Collection (CRDC) and the National Center for Education Statistics (NCES). These two data sets were selected due to the public availability, national statistics, large sample sizes, and ability to analyze. This thesis will aim to answer: what does the highest level of mathematics taken in high school by students look like nationwide, and more specifically what types of students are enrolling in more advanced math courses like calculus and AP calculus? Similarly, are racial and ethnic minorities still significantly underrepresented in more advanced high school math coursework and are females appropriately represented in high school math courses as argued by previous studies?

CRDC Descriptive Analysis

The CRDC is a survey that the United States' Department of Education's Office for Civil Rights conducts every other school year. This survey has been conducted since 1968 in hopes to keep track of specific indicators related to educational inequality and opportunity nationwide (Civil Rights Data Collection, 2014). The CRDC is used across the country by officials, researchers, policymakers, as well as the public, in order to analyze and keep track of educational equity in the United States. This thesis will draw from the 2013-14 National Estimates because this is the most recent data available for public analysis. This data is based on the self-reported U.S. public school districts. The reason this data set is deemed an “estimation” is that the CRDC is accounting for errors due to the nature of self-reporting. Some of the areas of error listed by the CRDC include: many sources, inability to provide accurate data, interpretation differences, collection, and missing data (Civil Rights Data Collection, 2014).

Although 2013-14 can be considered relatively old data, it is important to note that this data is also 11 to 12 years more recent than some of the longitudinal studies mentioned prior in this thesis that draw from data from 2002-03 or prior. This data set draws from all public local educational agencies that have grades 7-12. It is imperative to note the racial/ethnic makeup of United States public schools. For the purpose of this thesis, the focus will be on White, Black, and Latinx students. Although this thesis will refer to the ethnic group as Latinx to be more inclusive, some sources and researchers have chosen to use the label Hispanic. This thesis aims to be consistent with its research which is why the two terms are included throughout. Of the 49,917,157 public school students in the United States, 24.8% are Latinx, 15.5% are Black and 50.4% are White. When considering the public-school population by gender, males account for approximately 51.4% of the population, only a slight majority. Of the 25.6 million males, 12.7% are Latinx, 7.9% are Black, and 26% are White. Of the 24.3 million females, 12.1% are Latinx, 7.6% are Black, and 24.4% are White. The remaining percentages of males and females identify as other racial/ethnic groups that are not the focus of this thesis. It is important to consider that the differences in statistics for males and females are not statistically significant. Due to the slight majority of males in the U.S. public school system, the statistics for each gender and racial/ethnic makeup for males will be slightly higher than that for females, but no individual difference between the male and female percentage makeup for one race or ethnicity is significant. Figure 1 explicitly shows the total enrollment in U.S. public schools by race/ethnicity and gender.

Figure 1



i.e. This graph reads “of all U.S. Public School Students 12.7% are Latinx Males.” This data is drawn from the CRDC website.

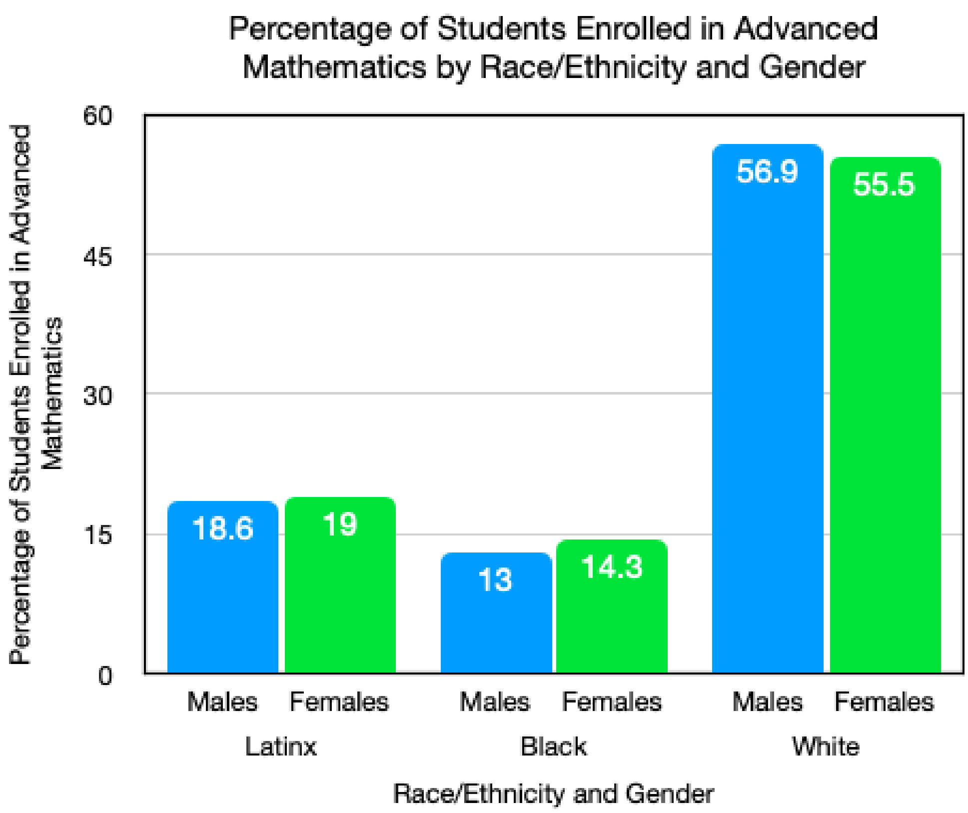
In order to understand the extent to which students of different genders and racial groups have access and are enrolling in math classes, this thesis will focus specifically on advanced mathematics courses, calculus, and advanced placement (AP) math. Of the 47,327 public schools that have grades 7-12, only 36% offer advanced mathematics. This data defines advanced mathematics as: “trigonometry, trigonometry/algebra, trigonometry/analytic geometry, trigonometry/math analysis, analytic geometry, math analysis, math analysis/analytic geometry, probability and statistics, and precalculus” (Civil Rights Data Collection, 2014). Similarly, of the 47,327 public schools that have grades 7-12, 26.7% offer calculus. Calculus is most commonly the highest level of mathematics offered in high school, therefore it would be considered the most advanced mathematics course of the list above. It makes sense that the percentage of public upper schools that offer calculus is lower than that of advanced mathematics, yet both percentages are shockingly low allowing for an interpretation that a minority of U.S public high schools are offering any advanced mathematics, let alone calculus. It is important to note that some of these schools offer dual degree programs or arrangements with community colleges allowing students to take advanced math elsewhere throughout high school, however this information is not publicly available on the CRDC website.

Not only will the offering of such math courses be considered, but also the enrollment by race/ethnicity and gender of such courses. Although the overall enrollment statistics mentioned above includes grades K-12 and these math courses are not offered until high school, it is plausible, due to the large sample size and the fact that high school is included in the K-12 statistics, to assume that the makeup of high schools mimics that of all grades K-12.

When examining the race/ethnicity and gender of students enrolled in advanced mathematics, Latinx and Black students are underrepresented while White students are overrepresented. More specifically, although there are slight differences in the female and male enrollment of the same race/ethnicity these differences are not significant. There are 2,475,389 U.S. public school students enrolled in advanced mathematics. Of these students, 18.8% are Latinx, 13.7% are Black, and 56.2% are White. When the enrollment of advanced mathematics is broken up by gender, of all the males enrolled in advanced math courses, 18.6% are Latinx, 13% are Black, and 56.9% are White. Similarly, of all the females enrolled in calculus 19% are Latinx, 14.3% are Black, and 55.5% are White. There is only a slightly larger proportion of Latinx females than males enrolled in advanced math, which could be considered insignificant.

Yet, the larger proportion of Black females compared to Black males enrolled in advanced mathematics is more apparent, however this does not mean the difference is significant. Opposingly, the proportion of White males is apparently larger than the proportion of White females. Figure 2 displays the percentage of U.S. public school students enrolled in advanced mathematics by race/ethnicity and gender. While the percentages of male and female representation in advanced mathematics by specific race/ethnicity are not entirely equal, they are extremely close.

Figure 2

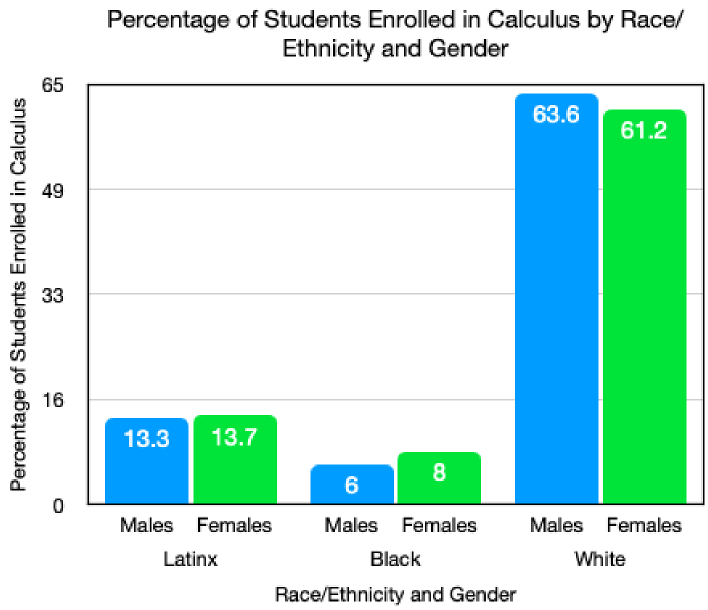


i.e. This graph reads "Of all public-school male students enrolled in advanced mathematics, 18.6% are Latinx".

This data is drawn from the CRDC website.

Similarly, when examining the race/ethnicity and gender of students enrolled in calculus, the enrollment of students in calculus follows a similar trend. Latinx and Black students are underrepresented while White students are overrepresented. Students enrolled in calculus include introductory calculus courses, honors calculus courses, and AP calculus courses. Therefore, there is some overlap with AP math and calculus enrollment. There are fewer students enrolled in calculus than advanced math due to the fact that if a student is following the typical mathematics track, calculus is taken following many of these courses that fall into the category of advanced mathematics. Of all 590,264 students enrolled in calculus, 13.5% are Latinx, 7% are Black, and 62.4% are White. When the enrollment of calculus is broken up by gender, of all the males enrolled in calculus, 13.3% are Latinx, 6% are Black, and 63.6% are White. Similarly, of all the females enrolled in calculus 13.7% are Latinx, 8% are Black, and 61.2% are White. While the male and female proportion of Latinx calculus enrollees seems nearly equal, the male and female proportion of Black and White calculus enrollees is not equal. There is a slightly larger proportion of White males than White females enrolled in calculus, while conversely there is are slightly more Black females enrolled in calculus than Black males. While these gender differences are apparent, they are relatively small and insignificant. Figure 3 displays the percentage of U.S. public school students enrolled in calculus by race/ethnicity and gender. Here the clear overrepresentation of White students and the underrepresentation of Latinx and Black students enrolled in calculus is apparent. There are not significant differences in terms of gender.

Figure 3

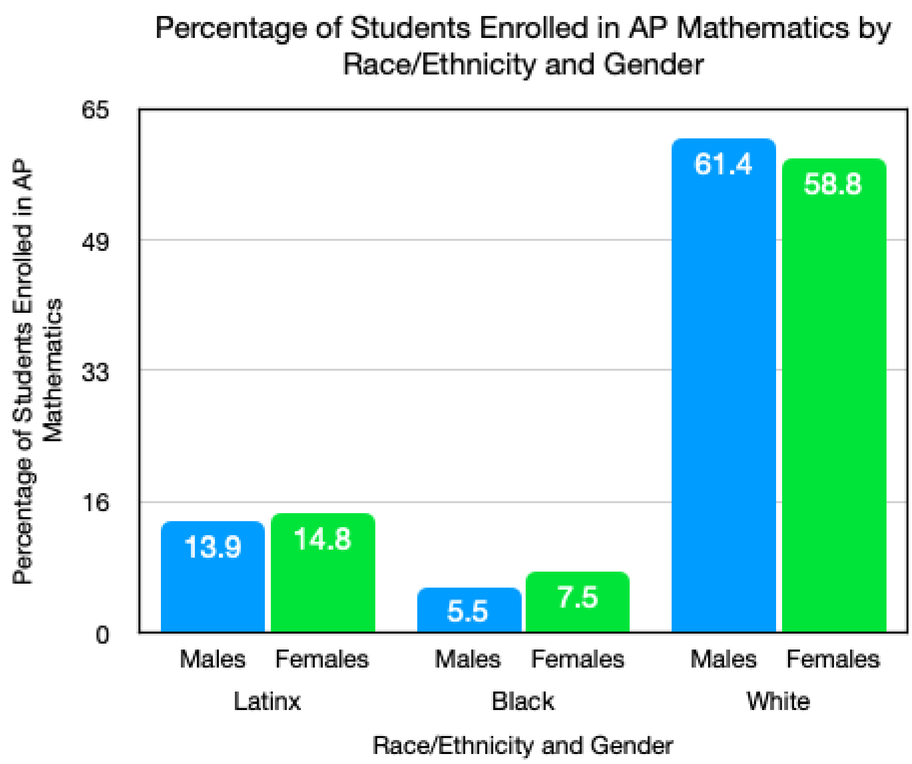


i.e. This graph reads "Of all public-school male students enrolled in calculus, 13.3% are Latinx". This data is drawn from the CRDC website.

I find even worse disparities by race when looking at AP enrollment. This is as predicted as AP mathematics is more advanced than both advanced mathematics and calculus and the disparities are predicted to increase with the level of math. When discussing the enrollment in AP mathematics, there are currently only three AP math courses offered: AB Calculus, BC Calculus, and AP Statistics. There are 605,354 students enrolled in AP mathematics, 14.3 % of these students identify as Latinx, 6.5% identify as Black, and 60.1% identify as White. When breaking down the enrollment of AP math by gender, of the male students enrolled 13.9% are Latinx, 5.5% are Black, and 61.4% are White. For females, 14.8% are Latinx, 7.5% are Black, and 58.8% are White. The proportion of Black and Latinx females enrolled in AP math is evidently higher than that of Black and Latinx males respectively. Conversely, the proportion of White males enrolled in AP math is higher than that of White females, but again these gender variations are not large enough to be deemed significant. Figure 4 displays the percentage of U.S.

public school students enrolled in AP mathematics by race/ethnicity and gender. Again, there appears to be significant overrepresentation of White students and underrepresentation of Latinx and Black students enrolled in calculus is apparent but not significant. There are not significant differences in terms of gender, aligning with previous research.

Figure 4

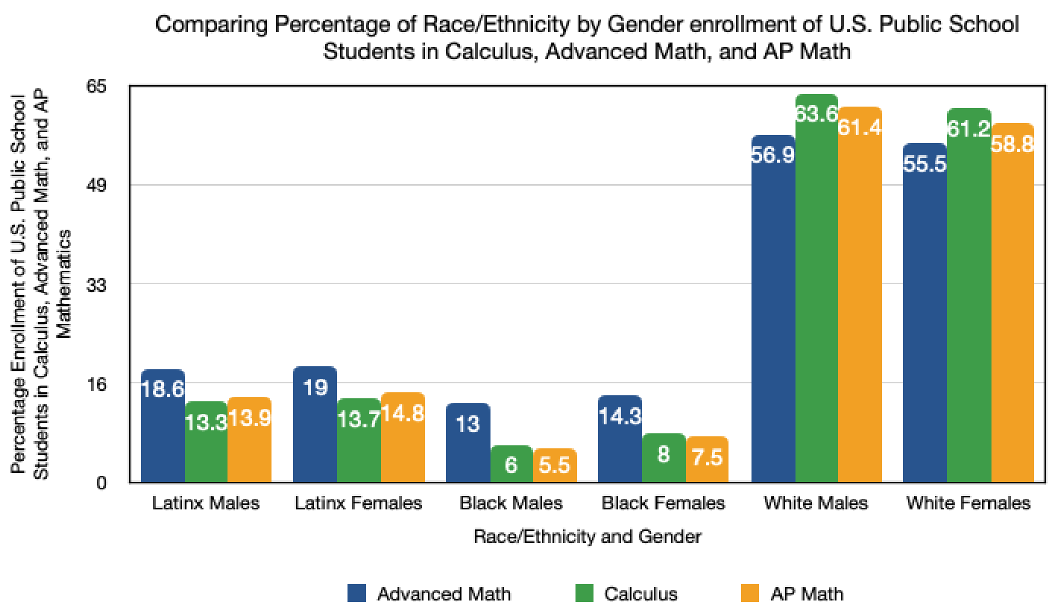


i.e. This graph reads "of all public-school male students enrolled in AP mathematics, 13.9% are Latinx". This data was collected from the CRDC website.

When interpreting and analyzing these results, it is evident that there are more students enrolled in advanced math courses than calculus due to the nature of the mathematics track. There are more students enrolled in AP mathematics than the broad category calculus because the AP mathematics students include AP statistics and two levels of AP calculus. The CRDC statistics show that Black and Latinx students account for larger percentages of advanced mathematics students than calculus students. This is predictable, due to the fact that for the purpose of this thesis, calculus is an even more advanced mathematics course. Yet, White students' representation increases significantly in calculus enrollment relative to advanced mathematics enrollment. In other words, representation of Latinx and Black students in math courses decreases when reaching calculus on the typical mathematics track, while White representation increases in the most advanced math courses. When accounting for the representation of White, Black, and Latinx students in U.S. public schools reported by the CRDC, in the enrollment of advanced math and calculus, Black and Latinx males and females are underrepresented while White males and females are over represented. The overrepresentation of White males and females is significant and apparent specifically for calculus, while the underrepresentation of Black and Latinx males and females peaks here too.

The CRDC data aligns with previous longitudinal studies and historical trends in the U.S education system but highlights this issue specifically in terms of calculus enrollment. The transition from advanced mathematics enrollment to calculus enrollment is distressing as Black and Latinx representation significantly decreases from already underrepresented proportions, while White representation increases significantly from already overrepresented proportions. Having exposure and enrollment in calculus has been proven to significantly increase the liklihood of studying/majoring in STEM, and these enrollment inequities are only contributing to the cycle of STEM underrepresentation. Figure 5 compares the percentage of U.S. public school students enrolled in advanced math, calculus, and AP mathematics by race/ethnicity and gender. Consistent with previous studies, the gender representation by race/ethnicity does not seem significant. However, the representation shrinks for Black and Latinx males and females from advanced math enrollment to calculus enrollment, while the opposite takes place for White males and females.

Figure 5



i.e. This graph reads "of all public-school male students enrolled in advanced mathematics, 18.8% are Latinx. Of all public-school male students enrolled in calculus 13.3% are Latinx. Of all public-school male students enrolled in AP Math 13.9% are Latinx". This data was collected from the CRDC website.

The most important conclusion from these comparative statistics is that while for Latinx and Black males and females the proportion of students enrolled in advanced mathematics is greater than that of calculus, understandably, due to the nature of the mathematics track, the opposite occurs for White males and females. The already underrepresented Black and Latinx males and females in advanced math are even more underrepresented in calculus, while the already overrepresented White males and females in advanced math are even more represented in calculus courses (Civil Rights Data Collection, 2014).

NCES Descriptive Analysis

The National Center for Education Statistics, NCES, collects national data from public schools annually, as well as longitudinal studies, in order for the public and educational researchers to conduct analyses. The High School Longitudinal Study of 2009, HSLS:09, follows upwards of 23,000 public school 9th graders with follow-ups in 2012 and 2016. The study surveys parents, students, school teachers and administrators and assesses different areas imperative in a child's education, such as class enrollment, race/ethnicity, test scores, perceptions and aspirations.

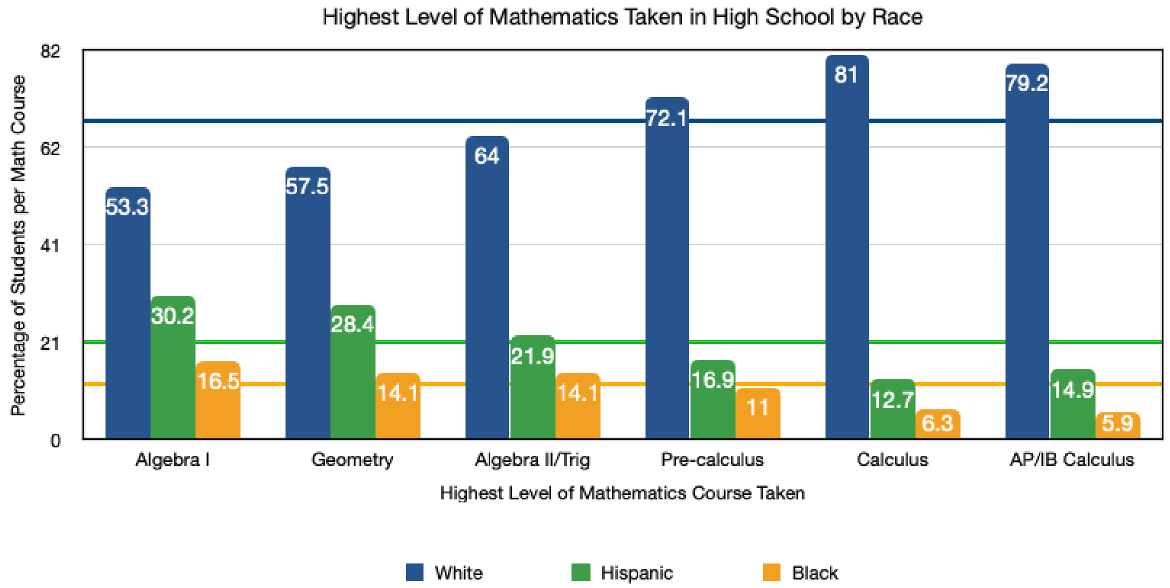
Using this data set, this thesis aims to answer similar a question: how are Black, White, and Latinx students represented when examining the highest level of mathematics taken in high school? This thesis will specifically look at two of the many available variables, race and highest level of mathematics taken in high school. Using the software SPSS, the HSLS:09 public use data was analyzed using a chi-squared test, as well as observing overall statistics of representation by race in certain math courses. It is important to note, the typical high school math track is: Algebra 1, Geometry, Algebra 2/ Trigonometry, Pre-Calculus, Calculus. The mathematics track varies across high schools and from student to student, especially as the college admissions process has become more competitive. Some students are opting to take courses earlier on in their education, as well as taking courses over the summer in order to get ahead and reach the highest possible course. The 2009 data was downloaded from the HSLS website and filtered to only consider White, Black, and Hispanic students. There were thirteen available options for the highest level of mathematics taken, ranging from no math to AP/IB calculus. This thesis will focus on the courses in the traditional mathematics pipeline: Algebra I, Geometry, Algebra II / Trigonometry, Pre-Calculus, Calculus, and AP/IB Calculus. It is important to note that this sample had 13,187 students and was 67.3% White, 12% Black, and 20.7% Hispanic. These are the statistics that the demographics of each course should be compared to.

As the highest level of mathematics taken in high school increased, Black and Latinx students became more underrepresented while White students became increasingly overrepresented. The analysis showed that of the U.S. public high school students whose highest level of mathematics was Algebra I, typically completed in 9th grade, 53.3% were White, 16.5% were Black, and 30.2% were Hispanic. Hispanics and Blacks are overrepresented here, while Whites are underrepresented. Of the students whose highest level of mathematics was Geometry, typically completed in 10th grade, 57.5% were White, 14.1% were Black, and 28.4% were Hispanic. Hispanics and Blacks are slightly less overrepresented here than Algebra I yet still overrepresented, and Whites are slightly less underrepresented. Students whose highest level of mathematics was Algebra II/ Trigonometry, typically completed in 11th grade, 64% were White, 14.1% were Black, and 21.9% were Hispanic. Blacks are still overrepresented, yet there was no shift in percentage of Black students whose highest level of math was Geometry and Algebra II/ Trig. Hispanics are only slightly overrepresented in this category of Algebra II / Trig and experienced a large decrease in percentage of students whose highest level of math was Geometry to Algebra II / Trig. Whites are slightly underrepresented but still experienced an increase in percentage of students who make up this category as well.

Pre-Calculus is typically taken after Algebra II/ Trig., however some students skip this course and move straight onto calculus. Of these students whose highest level of mathematics was Pre-Calculus, 72.1% were White, 11% were Black, and 16.9% were Hispanic. This is the course that transitions to Whites being overrepresented and Blacks and Hispanics being underrepresented. This only increases when advancing to calculus, typically taken in 12th grade, where 81% of students whose highest level of math taken was calculus were White, 6.3% were Black, and 12.7% were Hispanic. These statistics only differ slightly when considering AP/IB Calculus, or an advanced calculus course, as the highest level of math taken where 79.2% were White, 5.9% were Black, and 14.9% were Hispanic. It is evident that White students are underrepresented and Black and Hispanic students are overrepresented in the proportion of students whose highest level of mathematics is a course taken before Pre-Calculus. Yet, White students are overrepresented and Black and Hispanic students are underrepresented in the proportion of students whose highest level of mathematics is a course taken after Pre-Calculus. This representation inequality is dramatic when looking at calculus and AP/IB calculus as the highest level of math taken.

To test whether there were disparities in racial representation at the highest level of mathematics taken in hgh school, I performed a chi squared test. The two variables involved in this test were students' race and their highest level of mathematics taken down the pipeline and the p-value in this situation calculated by SPSS was 0.000. This can be interpreted to mean that the null hypothesis that these two variables are independent, is rejected. In other words, these percentages are statistically significant and there is clear under and over representation by race of students' highest level of mathematics taken in high school. Figure 6 below compares the statistics listed above as well as 3 lines to reference the sample size proportions by race, in order to see the over and under representation. For example, the blue line, marked at 67.3% indicates that 67.3% of the sample size was White. The green and yellow lines represent the proportion of the sample size that is Hispanic and Black respectively.

Figure 6



i.e. this graph reads "Of all U.S. public school students where Algebra I was the highest level of mathematics taken in high school, 53.3% were White, 30.2% were Hispanic, and 16.5% were Black. This data is drawn from the HSLS:09 dataset.

When analyzing the socio-economic status of a student and their enrollment in calculus, the chi-squared test also concluded that the relationship between a student's socio-economic status and whether or not they enroll in calculus is statistically significant. As expected, the lower socio-economic status children are less represented in calculus classes than those of higher socio-economic status. As the socioeconomic status of a student increases, so does the likelihood that they take calculus and vice versa. It is not shocking that this is the outcome, given the strongly correlated relationship between race and socioeconomic status, which is deep rooted in the United States history and society. When examining race and socio-economic status, as aligned with the U.S. national statistics, the lower the socio-economic status the more

Black and Hispanic students are overrepresented, whereas White students are underrepresented and vice versa (Radford, 2018).

Existing Solutions and their Strengths and Weaknesses

There is not one clear cut solution that will increase representation in the STEM fields for females and people of racial/ethnic minorities due to the number of factors that cause underrepresentation to begin with. Yet many existing solutions exist to attempt to increase representation in some way, either for a specific demographic or field.

STEM Inclusive High Schools

STEM inclusive high schools exist in order to increase STEM exposure to students. STEM inclusive high schools have been historically exclusive and require rigorous academic testing and standing upon admission, and the federal government has attempted to make these high schools more inclusive, in order to give traditionally disadvantaged students, access to STEM education. LaForce, Zuo, Ferris, and Noble conducted a study in 2019 on STEM Inclusive High Schools, and how the specific strategies implemented within these schools affect students' feelings towards pursuing a future career in STEM, their attitudes about STEM classes, and their confidence in science classes. There is a framework implemented by LaForce et al. called "the 8 Elements" (LaForce et al., 2019) that encompasses the goals of these schools, and of those 8 elements, the first five are determined to be "student-facing," meaning, they are ultimately aimed at achieving the goals that the schools have for the students. These student-facing elements are: "Problem Based Learning", "Rigorous Learning", "Personalization of Learning", "Career, Technology, and Life Skills", and " School Community and Belonging". LaForce’s study included 20 STEM inclusive high schools in 7 different states, and the schools were located in urban, suburban, and rural areas. This particular case measured different conditions: "Science intrinsic motivation", "Science ability beliefs", "Interest in future stem careers", and "cumulative GPA". Two analyses were conducted. Analysis 1 measured the number of "problem-solving projects", "supportive relationships", and "student culture" and how this related to students' attitudes about STEM. Analysis 2 measured "autonomy", "cognitively demanding work", "interdisciplinary content", "technology use", and "cooperation and teamwork" and how this influenced students' attitudes around STEM. The results showed that even in these schools that are designed to increase diversity in the STEM fields, there are still significant gaps when it comes to attitudes and confidence regarding the sciences (LaForce, 2019).

LaForce et al. concluded that access to these schools alone is not enough to diminish the gaps surrounding gender and race in STEM. It is not sufficient to group all STEM inclusive high schools together. It is necessary to look specifically at certain strategies implemented in these schools that are successful. Their study suggests that even in these schools that are designed to increase diversity within the STEM fields, there are still significant gaps when it comes to attitudes and confidence regarding the sciences. Access to these schools alone is not enough to diminish the gaps regarding gender and race in STEM. This study found that strong relationships have the potential to increase Hispanic/Latinx students' beliefs regarding their competence in science. Similarly, this study concluded that Black students reported having higher levels of motivation in science courses when they receive significant cognitive demanding work. This allowed the researchers to conclude that "rigorous teaching with an emphasis on critical thinking and reasoning skills in science classes may provide a potential benefit for Black students" (LaForce, 2019). This is not to say that this emphasis is not true for all students, however, LaForce's research was looking specifically at minority students and implementations that can increase representation in STEM. While this exposure to the STEM fields provides a more diverse group of students with access to STEM curriculum, it is not enough. Each minority group, and its intersection with gender behaves differently, which is why access and exposure alone do not diminish these gaps. However, while these high schools are increasing participation in STEM courses in college, they do not reduce the gaps entirely. It is possible that future STEM focused high schools can adapt aspects of LaForce's work to see which strategies are successful and which are not in order to continue to work on implementing solutions that will in fact reduce gaps for the future (LaForce, 2019). STEM inclusive high schools and other high schools can implement the research conducted in this thesis and previous studies to increase minority representation in STEM. In other words, increase female representation in STEM teachers and alter the narrative so that STEM careers are perceived to be more communal goal oriented. For racial/ethnic minorities it is more about evening academic preparation and here, STEM inclusive high schools found different ways that increased Black and Latinx students' representation.

HBCUs

Marybeth Gasman and Thai-Huy Nguyen out of the University of Pennsylvania (2014), examined Historically Black College and Universities' (HBCUs) role on improving the STEM pipeline. The number of Black students earning bachelor degrees has been increasing at a faster rate than the increase in all students earning bachelor degrees (Gasman, Nguyen, 2014). Although this is a positive statistic for Black students, the amount of bachelor degrees in STEM is also increasing for Black students but at a slower rate than other fields (Gasman, 2014). Gasman and Nguyen argue that academic preparation is the largest factor attributing to the slower rate of bachelor degrees in STEM for Black students relative to other degrees. This is consistent with this thesis and previous research on academic preparation, which tracking is a part of. Although the rate for STEM bachelor degrees is not increasing as fast as other fields, "in 2010, 8.6% of bachelor's degrees in science and engineering were awarded to Blacks ; HBCUs contributed 19.2 percent to that aggregate" (Gasman, 2014). This is an important statistic to note, considering HBCUs account for "less than 3 percent of postsecondary institutions" (Gasman, 2014). Regardless of the nationwide slower growth for Black bodies in STEM, "HBCUs continued to play a prevalent role in increasing the number of minorities in the sciences" (Gasman, 2014).

HBCUs are incorporating different solutions in order to increase the success and representation of Black bodies not just in STEM but in the workforce generally. Because the STEM growth is slower, HBCUs have incorporated three main approaches in order to speed up the growth and continue on the upward trend of increasing STEM bachelor degrees. HBCUs are promoting the celebration of success in STEM (Gasman, 2014). Celebrating Black students' success in STEM creates "an atmosphere that celebrates participation and accomplishment" (Gasman, 2014). Secondly, HBCUs are encouraging peer mentoring. This promotes more collaborative learning and less competition between students which also is proven to promote success. The last approach discussed by Gasman and Nguyen is to increase participation in undergraduate research (Gasman, 2014).

It is fair to say that Black students are advancing in the STEM fields but there is still significant room for improvement. HBCUs can learn from one another and other non HBCU secondary institutions can learn from the positive progress and success for minority students in STEM. The researchers ultimately conclude that "the success of HBCU students is attributed to a classroom and campus culture predicated on communal success (interdependent) as opposed to a ‘weed out’ culture based on competitiveness and individual progress (independent). Working together, as opposed to against each other is the key to these institutions’ success” (Gasman, 2014). It is imperative to note that HBCUs are not the solution to eliminate Black underrepresentation in STEM, but HBCUs are contributing significantly to representation in STEM and other institutions can learn from this positive impact in order to make up for the unequal academic preparedness that arises from systematic racism in the United States.

Informative Sessions- ADVANCE

Another key to reducing underrepresentation is education and discussion. Specifically, when focusing on women underrepresentation in STEM, this is more about the role models, goals, and reducing stereotypical gender socialization. Shaw et al. (2019) studied Oregon State’s program, ADVANCE, that aims to educate both men and women professors during multiple seminars about underrepresentation of women in STEM. These informative sessions are meant to expose college faculty to issues that are causing oppression and inequality at their specific institution. The participants are fully immersed for a little over a week, and after learning about the drawbacks causing the underrepresentation, are encouraged to invent possible solutions and amendments to policies at the given institution. The main goal of ADVANCE is to increase female STEM faculty at research institutions, and the results of the study showed that hosting ADVANCE over the past several years has done exactly that. Not only has this program increased the diversity of OSU’s STEM faculty, but also has caused the participants to look at academia in a more enlightened way, with hopes for change. Other institutions and places of employment have been implementing seminars and educational discussions similar to ADVANCE, as the issue leading to this inequality in many cases is ignorance. If people are made aware of the concrete statistics regarding underrepresentation of women and people of color in the STEM field, ideally, people will tend to be more cognizant and aware of the issue at hand. Once people understand the gaps and are passionate enough to create change, that is when those minds will come together to implement change that will narrow and reduce these gaps (Shaw, 2019). This ADVANCE program is about women STEM faculty, in other words attacking the problem of representation at the very top end of the education pathway.

It is clear that the underrepresentation in STEM is an issue that many scholars, researchers, and educators are passionate about, and many potential solutions have been implemented in order to promote change. Due to the varying factors that affect different groups' underrepresentation, there has not been one unique solution proposed that entirely eliminates the evident gaps. However, there are pieces of many existing solutions that can be combined and implemented in order to continue to create the best possible solutions and more opportunities for women and people of color in STEM.

Conclusion

It is evident that women and people of color are underrepresented in the STEM workforce in the United States and for different reasons. This is a significant problem because diversity is beneficial in working environments and individuals should be able to pursue a path that interests them regardless of race, ethnicity, and/or gender.

It is not so simple as to pinpoint one step in a students' journey that leads to this inequality and underrepresentation as every student's career is different. This thesis touched upon many aspects that play a role in a child's education, such as their school district, teachers, tracking, race, gender, parental involvement, socio-economic status, etc. However, there are trends that are evident; people of color are underrepresented in higher level high school mathematics courses while White students are overrepresented, and people of color are overrepresented in lower levels of high school mathematics courses while White students are underrepresented. Likewise, these students in less advanced courses are not only covering less material, but are also being exposed to less engaging and insightful material. This is significant because the level of mathematics taken in high school plays a critical role on the students' involvement and enrollment in STEM courses in college, which will ultimately play a role in students pursuing STEM careers in the workforce.

Conversely, females are not underrepresented in high school mathematics courses, but they experience underrepresentation for reasons linked to gender socialization. These include role models, goals, and attitudes. More specifically, how STEM careers are perceived to align with communal goals and how females are more likely to choose a profession that aligns with communal goals.

For students who have already been exposed to calculus and in some circumstances pre-calculus (for which the data shows people of color are significantly underrepresented while White students are overrepresented) enrolling in a calculus course in college serves as a review. This can cause these "pre-exposed" students to feel confident in their calculus abilities, which is a prerequisite for almost every STEM major and pipeline in college. This confidence and competence can cause students to enroll in similar courses or stick to a similar course path in college because as humans, we like to continue and learn in areas in which we excel and succeed. Conversely, a student who has not been exposed to calculus or pre-calculus (for which the data shows people of color are significantly overrepresented while White students are underrepresented) will be placed at a disadvantage if they chose to enroll in a college calculus course in their first year of college. Calculus is a challenging subject and the transition from high school to college courses and instruction can make this introductory course stressful. These students are more likely to fall behind and have a negative sentiment for calculus or math in general. If a student does not thrive in this course, they might not choose to peruse a STEM major.

This is not to say that the enrollment in high school mathematics course is the only factor that impacts racial/ethnic underrepresentation in STEM, but that it is an important factor that can be researched further. Many of the other contributors to underrepresentation can be difficult to manage or monitor on such a large scale such as school district, taxes, parental history, etc. as these all have complex deeper seeded issues in the United States' history and society. But, promoting more advanced courses to be offered in every public high school, particularly calculus, can have an impact on a student's decision to continue learning in STEM. Along with this increase in exposure and opportunity for students, it is imperative to stress the importance of high-level mathematics learning to students, faculty, and their parents and encourage as many students as possible to take the highest level of math appropriate. The mindset should shift from taking a course that a college admissions recruiter would want to see, to taking advantage of the opportunity to learn more and get ahead in order to be more prepared when it comes to college courses and beyond. The emphasis should be placed on encouraging students of color to enroll in these high school courses by explaining their worth and importance.

It is probable that many students only take the bare minimum of mathematics coursework needed in order to obtain a high school diploma, which varies from state to state. Some states only require two years of mathematics while others require all four years. It would be beneficial for states to implement a four-year requirement of mathematics, similar to an English requirement, so that students are more inclined to move up the mathematics pipeline.   These misrepresentations are not emerging in high school as noted previously due to tracking, elementary school teachers, resources, etc. but high school is a pivotal time where these inequalities have an opportunity to be decreased slightly due to exposure of more advanced material and more freedom to choose coursework that is of interest to the student.

This exposure to more advanced math courses like pre-calculus and calculus, not necessarily advanced placement or honors level courses, can provide students with the foundation and opportunity to succeed in calculus and other upper level math courses in college. This success can build confidence and passion to enter the STEM workforce and demolish the idea of the stereotypical STEM worker, a White male. On the opposite end, stressing the significance of female role models and communal goals in STEM careers has the potential to increase female representation in STEM. The possibility to promote growth, change, and equal representation is up to everyone, not just education and policy researchers, to promote seizing the most challenging and rewarding opportunities, one upper level math course and role model at a time.

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Author Biography

I am a mathematics major at the University of Texas and grew up in Newton, Massachusetts. During my time here in Austin, I was an active member of Alpha Epsilon Phi, Texas Chabad, and Polymathic Scholars. I love to try out new Austin restaurants, practice yoga, dance, and scuba dive. My interest in this topic started when I took a class in high school titled "Leadership in a Diverse Society". I was exposed to a more diverse makeup of students, learned about the METCO program and the true issues of racism and bias in our country. My interest has continued to grow as I engage in interesting conversation and debate, take classes here at UT, and read relevant literature. After graduation, I will work at PricewaterhouseCoopers LLC. in New York City, as a financial consultant. I hope to one day use what I learned throughout my thesis to apply a more analytical lens to education and policy reform.